The Role of Chemically Depleted Mantle in the Formation of Coronae on Venus

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Without extensive plate subduction to act as a recycling mechanism, a thick layer of buoyant, depleted mantle material may accumulate beneath the thermal lithosphere on Venus due to the pressure-release melting that occurs during crustal formation [Parmentier and Hess, 1992]. Such a layer could be the key factor that allows coronae to form on Venus but not on Earth. Coronae are roughly circular volcano-tectonic features that are interpreted as a manifestation of small-scale upwelling [e.g. Stofan et. al., 1992] and are unique to Venus. The topographic expression of coronae is highly variable, ranging from domes to plateaus, with or without moats or single or multiple outer rises. In addition to why coronae form on Venus but not on Earth, two outstanding questions in the study of coronae are how the full range of topographic profiles arc produced and the relationship between topography and the annulus of fractures that characteristize coronae. Domes, plateaus, and moats can be formed by thermal relaxation of a topographic high due to a cooling of a hot upwelling, but the formation of outer rises, and particularly multiple outer rises, can not. Relaxation can also produce fracture annuli. However, observed annuli frequently do not occur in any given position relative to the topography and are thus not predicted by relaxation models. The presence of a layer of depleted mantle material beneath the thermal lithosphere in models of upwellings introduces a buoyant force that can produce the full range of observed topography and cause the surface near the outer edge of the upwelling to be flexed up and down over the course of the evolution of the upwelling such that fractures could be produced in locations that do not correspond to the final topography. Further, the density/viscosity conditions in the depleted layer can result in coupled upwelling and downwelling that can explain the dual upwelling/trench nature observed at some coronae. This thermal downwelling pulls the buoyant mantle material downward until the thermal cools to the point where the thermal buoyancy is less than the chemical buoyancy, at which point the thickened region of buoyant material produces an isostatic ring at the surface. Heng-o Coronae may be typical of this process. Axisymmetric finite-clement models of small scale upwellings that produce a range of topographic profiles and downwellings that result as a natural consequence of the upwelling will be presented.

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